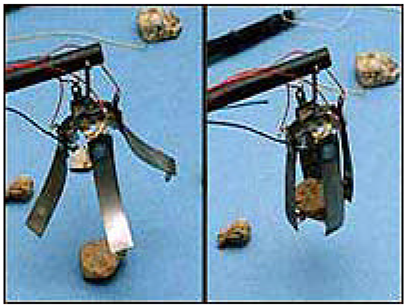
### SPACE ROBOTS



**An electric charge applied to these electroactive-polymer ribbons cause one side of the ribbons to lenthen and the opposite sides to shorten. The result is a robotic hand that can grasp rocks.**

**Image: NASA**

# Space Robots Get Artificial Muscles

Fitness fanatics aren't the only ones getting pumped up. Space rovers at NASA are beefing up with artificial muscles that flex and contract. Although they won't win any strong-men competitions, the rovers will use their abilities to explore where no human has gone before: the asteroid 4660 Nereus.

The muscles were developed by Yoseph Bar-Cohen and his colleagues of JPL's Nondestructive Evaluation and Advanced Actuator Technologies and work when the scientists apply an electrical volt to a lightweight, highly flexible plastic called electroactive polymers (EAPs). Typical robotic arms use gears, hydraulics and other expensive, heavy, parts that drive up cost and energy requirements on space missions.

But the EAPs could change all that. They allow robotic hands to grip and grab and lift and drop loads, helping them to perform tasks such as collecting and manipulating soil, ice or rock samples.

"That's just the tip of the iceberg when it comes to space applications, " says Bar-Cohen. "Electroactive polymers are changing the paradigm about the complexity of robots. In the future, we see the potential to . . . build simple robots that dig and operate cooperatively like ants, soft-land like cats or traverse long distances like a grasshopper."

To meet these challenges, Bar-Cohen and his team have developed two types of artificial muscles that respond quickly to small amounts of electricity by lengthening or bending.

The first is a flexible ribbon made from chains of carbon, fluorine, and oxygen molecules. When an electric charge flows through the ribbon, charged particles in the polymer get pushed or pulled on the ribbon's two sides, depending on the polarity. The net result: The ribbon bends. Using four such ribbons, Bar-Cohen has fashioned a gripper that can pick up a rock.

The second consists of thin sheets wrapped into cigar-like cylinders that stretch when one side of a sheet is given a positive charge and the other a negative charge. These charges cause the wrapped sheet to contract toward the center of the cylinder, and this constriction forces the cylinder to expand lengthwise. When the power supply is turned off, the cylinder relaxes, enabling it to lift or drop loads.

NASA will test the technology in space in 2002 when the Japanese launch the Mu Space Engineering Spacecraft. This mission will deploy a NASA-supplied rover onto the asteroid 4660 Nereus where it will gather photographs and collect samples.

Years from now, EAP devices could also conceivably replace damaged human muscles, leading to partially "bionic" men women of the future, according to Bar-Cohen and his fellow researchers.

"My hope is someday to see a handicapped person jogging to the grocery store using this technology, " said Bar-Cohen.

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